THE PALEOZOIC FORMATIONS SOUTH OF THE SAN SABA RIVER

IN MCCULLOCH COUNTY, TEXAS

Approved:

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Dean of the Graduate School.

June 1, 1932.

THE PALEOZOIC FORMATIONS SOUTH OF THE SAN SABA RIVER IN MCCULLOCH COUNTY, TEXAS

THESIS

Presented to the Faculty of the Graduate School of The University of Texas in Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

By

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(Austin, Texas)
Austin, Texas

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PREFACE

I wish to express my appreciation to Dr. E. H. Sellards of the Bureau of Economic Geology and the Graduate Faculty of the University for directing this work and to Professor F. B. Plummer, of the Bureau of Economic Geology and the Petroleum Engineering Faculty of the University, and Professor A. H. Deen, of the Geology Faculty, for serving on my committee. To Mr. and Mrs. Frank Kidd, whose ranch occupies most of the area studied, I am indebted for their generous hospitality and advice. To Mr. B. L. Pilcher, Jr. of Austin I am grateful for his valuable assistance in the field work.

G. Russell Sparenberg

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THE PALEOZOIC FORMATIONS SOUTH OF THE SAN SABA RIVER IN MCCULLOCH COUNTY, TEXAS

INTRODUCTION

The area which this survey covers lies entirely in the mid-southern part of McCulloch County, Texas, south of the San Saba River, west of the Mason-Brady, Texas State Highway Number Nine, and north of a line drawn from the United States Coast and Geodetic Survey Bench Mark Number V-76 (on Texas Highway No. 9) to the point where the San Saba River crosses the Mason-McCulloch County line. The shape of the area is that of an obtuse-angled triangle with the following dimensions: 8.73 miles, 2.96 miles, and 6.81 miles on its northern (and western), eastern, and southern boundaries, respectively.

The culture of the region is that of any rugged, sparsely settled ranching country--large, fenced pastures, widely scattered houses, windmills, and tanks connected by generally poor, rocky, private roads which are not passable in bad weather. The amount of cultivated land

is almost negligible, and no irrigating is done from the river. Without a town, school, church, or railroad, the area's most notable cultural feature is the paved highway on its eastern edge, which connects it with Mason, county seat of Mason County, 21 miles to the south and with Brady, county seat of McCulloch County, nine miles to the north. These measurements are from the San Saba River bridge, near which is the little settlement of Camp San Saba.

McCulloch County, correctly advertised as "The Heart of Texas," (In it is located the state's exact geographical center) is bound by the following counties: on the north by Coleman and Brown, on the east by San Saba, on the south by Mason and Menard, and on the west by Menard and Concho. Brady, the county seat, is served by the Fort Worth and Rio Grande and Santa Fe Railroads and is located 80 miles south of east of San Angelo and approximately 160 miles northwest of San Antonio.

METHODS USED IN MAKING SURVEY

Some time was spent in a reconnaisance survey of the area's roads, drainage system, chief topographic features, culture, distribution and character of the vegetation, and the geological formations before beginning the detailed map. This preliminary work greatly facilitated the subsequent plane table mapping.

All elevations are based on that of the United States Coast and Geodetic Survey Bench Mark V-76, 1748.379 feet, in the southeast corner of the area. From V-76 a traverse of marked stations was run first north on the highway to the San Saba bridge, thence southwest up the river to the Mason-McCulloch County line. A similar traverse, beginning again at V-76 and extending in a south of west direction to the termination of the first traverse, completed the peripheral survey of marked stations. These stations served as beginning and "tieing in" points for numerous cross traverses which were run over the more important topographic features.

Notes taken both in the reconnaisance work and in the topographic mapping furnished detailed and accurate

information on the geology. The locations of the best exposures were plotted and the sections were measured after the completion of the map.

With the exception of a small, obsolete United States Geological Survey topographic map with 50-foot contour intervals, no base map was available. For this reason a detailed, 20-foot contour map was made to serve as a base for the geologic mapping. The completion of the base map required by far the greater part of the time available for the survey.

PREVIOUS WORK IN THE AREA

Several geologists have done work in the adjacent regions in which rocks of the same age outcrop, but, so far as I know, no one has made a detailed study of the area discussed in this paper or published anything on it.

PHYSIOGRAPHY

Drainage

The area is drained by a number of small intermittent streams which flow in a northerly direction and empty into the San Saba River, a tributary to the Colorado River. That part of the drainage which flows eastward out of the area soon turns northward and reaches the San Saba. Ranch Branch, in the southwest corner of and the largest creek in the area, is the only one widely known and mapped on the United States Geological Survey map; the others are known only locally. All of them in their upper reaches have steep gradients which gradually decrease toward the river. Generally the drainage is more or less parallel with the strike of the formations.

The San Saba, flowing northeast, drops 59.1 feet in the area, an average of 6.76 feet per mile. It is a succession of long, still pools and short rapids and a few low falls. The water is generally clear and varies from a few inches to eight or ten feet in depth. Like many other streams with steep, rocky, sparsely covered watersheds the San Saba is well known for sudden and often destructive rises and corresponding periods of low water level. In fact, during times of prolonged drouth, its

bed is, with the exception of a few deep holes, entirely dry.

Topography

The hard, generally massive or flaggy limestones which cover the area have made it very resistant to erosion. The resulting topography is decidedly rugged with the creeks cutting deep valleys to form steep hills and in places almost sheer cliffs 60 to 80 feet high. The general west to north of west dip of the limestone beds and the northerly direction of flow of the small streams have formed a number of prominent east-facing escarpments. Flat, featureless localities are exceptional and of small size. Elevations vary from 1531.8 feet at the San Saba River bridge to 1875 feet in the southeast corner of the area--a maximum relief of 343.2 feet.

Vegetation

Along the San Saba valley willow, sycamore, elm, oak, pecan, and walnut predominate, while away from the river the trees are mainly mesquite, scrub live oak, and cedar. Thorny bushes and cacti grow in abuncance. In years of plentiful rainfall the area is fine grazing land for cattle, but generally the amount of grass grown makes it suitable only for goats and sheep.

STRATIGRAPHY

The area is covered entirely by Upper Cambrian and Cambro-Ordovician rocks, the former being represented by the Wilberns formation and the latter by the Ellenburger limestone. Of the last named formation only the lower portion (Cambrian) was found. It is doubtful if any true Ordovician is present, but the general classification of Cambro-Ordovician has veen followed in order to avoid misunderstanding. This classification is the same as that made by Sidney Paige in his description of the Central Mineral Region of Texas in the "Llano-Burnet Folio," United States Geological Survey Folio 183, 1912. It has been used because the two formations mentioned above possess very similar lithologic characteristics in both areas. In fact the area discussed in this paper forms a part of the western flank of the Central Mineral Region.

Cambrian

Wilberns formation-- The Wilberns is the youngest of the three formations which comprise the Upper Cambrian (exclusive of Cambro-Ordovician)of the Central Mineral Region. These formations are, in the order of their deposition, the Hickory sandstone, the Cap Mountain formation, and the Wilberns formation.

The Wilberns, named from Wilberns Glen, one and one-half miles south of the San Saba-Llano County line, on the Little Llano River, is of irregular thickness and is composed of limestone and shale and intraformational conglomerates.[1] According to Paige, the base

[1] Paige, Sidney, "Llano-Burnet Folio," United States Geological Survey Folio 183, 1912, p. 6.

of the formation is marked by the top of the glauconitic sandstone which is the upper member of the Cap Mountain formation. The base of the overlying massive chert-bearing beds (Ellenburger) marks its upper limit.

On lithologic criteria the Wilberns is divided into an upper and lower portion.

"The lower portion, comprising about two-thirds of the whole, is rather thin-bedded flaggy limestone generally mottled by sandy impurities and containing locally a small amount of glauconite. The upper portion is largely shale, with more limestone at the top. In the shaly portion there are several conglometatic lentils. These are not persistent along the strike, nor is their number everywhere the same. They are of two kinds--one composed of perfectly flat shaly limestone fragments, such as could be transported a very short distance, the other composed of rounded or almond-shaped calcareous pebbles in a matrix of decidedly oolitic texture containing locally considerable glauconite."[2]

[2] Paige, Sidney, "Llano-Burnet Folio," United States Geological Survey Folio 183, 1912, p. 6.

This description of the type locality of the Wilberns formation in the Llano-Burnet Quadrangles is applicable in a general way to the Wilberns of the area discussed in this paper. In lithologic characters the two sections, as a whole, are very similar; they differ only in the sequence and thickness of the individual beds. The section south of the San Saba River, even though it does contain a great deal of shale, is predominantly limestone; more so, I believe, than in the Llano River region. Where shale does occur it is always interbedded with limestone or limestone conglomerates and the separate beds are never more than four or five feet thick, usually much less. A general survey reveals first a hard, crystalline, rather pure, flaggy to massive limestone in the river bed which, higher in the section, becomes less and less massive and more and more contaminated with sandy, shaly, and conglomeratic impurities. The decrease in thickness of the limestone beds is marked by a corresponding increase in the thickness of the shale beds, but always the two are interstratified. The sequence is often broken by conglomerates. Farther up in the section the proportions of shale and limestone are reversed. The shale beds become thinner and those of the limestone thicker. In fact the shale becomes thinly laminated and disappears almost entirely, while the beds of limestone become

heavier and by the time the base of the overlying Ellenburger is reached, quite massive. Glauconite grains are found throughout most of the section and in places are so abundant that they give a dark green color to the formation. The beds of rather massive limestone do not occur exclusively in the lower and upper parts of the formation; they are found throughout the middle of the section also.

Although the Wilberns is known to be of irregular thickness, yet the 220 feet of the formation in the Central Mineral Region and the apparent thickness of 343.2 feet in this area stand in sharp contrast. This difference is due in part to much folding and some faulting. The increase in thickness caused by each fold or fault is not very large, but the aggregate of them all forms an appreciable amount. Due to their small individual size these numerous irregularities were not measured and mapped.

Blue-green algae are thought by Sellards[3] and Ulrich to be characteristic of the Wilberns. They are unknown in the Cap Mountain formation and the Ellenburger limestone. Of the several species that are

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[3] Personal interview with Dr. E. H. Sellards.

found only one, Girvanella, has been definitely identified. Due to their peculiar structure and abundant growth, these algal deposits are spoken of as algal reefs. They vary greatly in size, are widely scattered throughout the area, and are found in nearly all parts of the Wilberns section.

Two sections of the Wilberns were measured. In addition, a general composite section or study was made of the beds along Highway No. 9 from the San Saba River bridge to the top of a hill slightly over one mile to the south. Numerous small folds and faults rendered the taking of a reliable section impossible. The purpose of the study was to obtain information as to the character of the beds rather than to get accurate measurements of them. These characteristics have been given in the general description. It may be added, however, that it is in this part of the area that the thicker shale beds, interstratified with thin limestone beds, occur.

Unless otherwise specified the fragments of the conglomerates mentioned in the sections below are generally not over one-quarter of an inch in diameter. The texture may be described as partly oolitic. As a rule the inclusions mentioned mean a change in color only, not in character. They give the beds a rather mottled appearance.

Section I

Measured from the bottom of a draw immediately north of B. M. V-76 to the top of the hill in the south-east corner of the area. As read, the section proceeds from the top to the base.

	Ft.	In.
Pinkish brown, finely crystalline limestone.....	2	6
Brown, hard, finely crystalline, shaly and flaggy limestone.....	6	
Brown and gray, fine-grained, crystalline, banded limestone with algae.....	1	6
Hard, massive, whitish gray limestone with some brown inclusions, grading into a much harder, gray crystalline limestone.....	3	3
Gray to brownish gray conglomeratic limestone with glauconite grains.....	1	9
Hard, rather massive, crystalline, gray to brown limestone with algae. Thin beds of shale.....	12	
Hard, rather massive, smooth to finely crystalline, white to gray limestone with brown inclusions.....	10	6
Gray, sandy limestone beds, 6" to 1' thick.	5	3
Rather soft, greenish gray limestone with brown inclusions. Glauconitic but not conglomeratic. Beds generally 1' thick and separated by thin layers of brown shale.....	10	
Greenish gray, crystalline limestone with brown inclusions, glauconite grains and larger pebbles.....	1	6

Section I (con't)

	Ft.	In.
Alternating brown shale and impure limestone. Shale beds 1 to 3 feet thick. Limestone beds one-half to several inches thick; some conglomerate.....	26	
Gray to greenish gray conglomeratic limestone with brown inclusions and glauconite grains. Broken by thin beds of finely sandy shale.....	21	6
Alternating shales, sandy shales, and impure limestone.....	25	6
Alternating beds of brown and white conglomeratic limestone and brown shale.	11	4
Gray, flaggy limestone with inclusions of brown limestone and thin layers of shale. Numerous fossil fragments of crinoid stems and trilobites. Lingula sp. (4).....	15	
Rather massive beds of highly crystalline, gray to brown limestone.....	5	3
	158	10

(4) Wolcott, C. D., "Cambrian Brachiopoda." United States Geological Survey Monograph LI, 1912.

Section II

Measured on a steep hill overlooking the San Saba River in about the middle of the northern edge of the area. This section includes both the top of the Wilberns and the base of the Ellenburger. Approximately the upper 60 feet belong to the latter formation. The beds are generally rather massive, but

chert is found only in a few places and then in small quantities. As read, the section proceeds from the top to the base.

	Ft.	In.
Gray, hard, finely crystalline, smooth, massive limestone with loosely coiled gastropods	3	6
Gray, hard, crystalline, rather massive limestone which becomes less crystalline and more massive toward the top	25	
Gray, hard, fine-grained limestone with brown inclusions which grade into a slightly brownish gray limestone (last 15 feet)	25	
Almost pure gray, rather broken limestone containing trilobite fragments	5	
Gray limestone with brown inclusions. Poorly bedded	11	6
Almost pure gray, fine-grained, rather broken limestone	6	
Brown and gray, medium- to fine-grained, flaggy or rather massive limestone changing from brown with gray inclusions to gray with brown inclusions. There are lenses of shaly and sandy impurities, and the bedding is never well defined	30	
Brown, fine-grained limestone with gray inclusions	6	
Gray, very fine-grained, massive, poorly bedded limestone	18	
Gray to white, medium- to fine-grained crystalline limestone	2	
Brown limestone with gray inclusions	2	6
Gray, fine-grained limestone	0	6

Section II (con't)

	Ft.	In.
Brown, finely crystalline limestone with gray inclusions.....	2	6
Gray, finely crystalline limestone with a great many brown inclusions.....	8	
Gray, crystalline limestone with a few brown inclusions.....	3	
Gray, finely crystalline limestone.....	2	
Dark gray, hard, massive limestone with glauconite and conglomerate with larger fragments.....	3	
Rather conglomeratic, dark gray, hard, massive limestone with yellow inclusions and glauconite, alternating with beds of almost pure glauconite. Thin lentils of sandy shale.....	15	
Dark green, glauconitic limestone with brachiopods which are very similar to Billingsella coloradoensis Shumard (5)	1	
Alternating 6" to 12" beds of dark gray limestone with yellowish inclusions and dark gray limestone with some glauconite grains and dark green, very glauconitic limestone.....	3	

(5) Wolcott, C. D., "Cambrian Brachiopoda." United States Geological Survey Monograph LI, 1912.

Section II (con't)

	Ft.	In.
Dark green, very glauconitic limestone with some brown inclusions.....	3	
Dark gray, hard, massive, crystalline limestone, with some brown inclusions exposed in the river bed.....	0	
	175	6

Unfortunately very few good fossils were found, but numerous fossil fragments scattered throughout the Wilberns sections indicate an abundance of trilobites and brachiopods and some gastropods. The more fossiliferous beds are usually conglomeratic and glauconitic. Evidence of floral life seems to be represented chiefly by the blue-green algal reefs.

The Wilberns-Ellenburger Contact

The Wilberns-Ellenburger contact is not nearly so definitely defined in this area as it seems to be in the Llano-Burnet Quadrangles. In the latter the base of the Ellenburger is marked by massive, heavy chert-bearing beds, while in this area the beds, though quite massive, contain only small and occasional amounts of chert. Then,

too, the base of the Ellenburger is only slightly more massive than the top of the Wilberns. The change is decidedly gradual rather than abrupt. This gradual change is also observable in the color and crystallinity of the formations. In the upper beds of the Wilberns brown and gray colors are mixed and mottled with the gray becoming increasingly predominant as the Ellenburger is reached. The degree of crystallinity decreases upward. Glauconite disappears almost entirely and sandy and shaly impurities become increasingly scarce.

The Ellenburger apparently lies conformably on the Wilberns. There is no evidence of a hiatus. The sea water doubtlessly did change in depth, but deposition seems to have been continuous.

Cambro-Ordovician

Ellenburger limestone-- This formation is named from the Ellenburger Hills in the northwest corner of the Burnet Quadrangle. In that region it is perhaps 1000 feet thick. In this area only the lower portion is present and its thickness is not over 250 feet. Bedding is generally ill defined, and detailed sections are very difficult or almost impossible to obtain. The only section measured was that given in Section II.

The Ellenburger of this area can, however, be di-

vided roughly into three parts. First, the lower portion of light to dark gray, massive, finely crystalline, smooth limestone which contains small amounts of chert and forms prominent escarpments. Second, the middle pertion, which is rather quartzitic and in places almost pure quartz. In fact, the chemical composition has been so changed that the formation breaks down into rather angular pebbles, much after the manner of the weathering of granite. In contrast to the varied and comparatively abundant vegetation of the rest of the area, only a few scattered live oak trees and very little grass grow. The resulting topography is a number of well-rounded open hills and valleys. Third, the upper portion, of gray to brownish gray, flaggy to rather massive, crystalline limestone which forms rather prominent escarpments and steep cliffs. Of the three portions this is the most crystalline.

Fossils are more scarce in the Ellenburger than in the Wilberns formation.

Correlation

According to Paige[6] the Upper Cambrian of the Central

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[6] Paige, Sidney, "Llano-Burnet Folio, "United States Geological Survey Folio 183, 1912, p. 7.

Mineral Region, which includes the Wilberns formation, is "correlated with the Reagan sandstone of Oklahoma and with the Upper Cambrian beds of Missouri. There are also marked general lithologic resemblances between the Texas beds and the Deadwood formation in the Black Hills of South Dakota and eastern Wyoming and in the Big Horn Mountains of central Wyoming. The faunas, too, have many species in common."

Richardson[7] states that the Upper Cambrian of central Texas has approximate equivalents in the Bliss sandstone of the Franklin Mountains, the "Tonto" sandstone of the Grand Canyon, the Bolsa quartzite of Bisbee, the Coronado quartzite of Clifton, and the Reagan sandstone of Oklahoma. To these may be added the Van Horn sandstone of the Van Horn Region, Texas, and the Dagger Flat sandstone of the Marathon and Solitario Regions, Texas.

Correlations generally consider the Ellenburger limestone as Lower and Middle Ordovician and give it equivalents of that age, quite different of course from those of Upper Cambrian. But, since the basal Ellenburger present

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[7] Richardson, G. B., "El Paso Folio," United States Geological Survey Folio 166, 1909, p. 3.

in this area is considered Upper Cambrian, its equivalents must be of that age, or approximately the same as the equivalents of the Wilberns formation.

STRUCTURE

The rocks of this area have a general west and west northwest dip of from two to five degrees. The strike varies from 10 to 15 degrees east of north. Numerous small faults and folds of varying size are present, with their respective planes and axes both parallel and at right angles to the strike of the formations. Some of the sharp folds are almost isoclinal; others are overturned and accompanied by thrust faults. Still other folds, particularly those caused by the growth of numerous blue-green algal deposits, are dome-shaped and vary in diameter from a few inches to well over one hundred feet. In addition, the San Saba River has cut through the crests of several rather large anticlinal folds. Pictures of two of these are shown in Figures 1 and 2. Their positions on the map are shown with the usual dip symbols, as are the locations of a few

synclinal folds and the larger domes formed by the algae.

The largest fault of the area, which exhibits considerable throw, runs parallel with the strike of the formations. Due to the similarity of the beds in which it lies the amount of displacement could not be determined, but reverse dips of from 10 to 15 degrees were observed and in places the beds were turned upright. This large fault, in the middle southern part of the area, is the only one shown on the map.

An explanation of these irregularities, particularly the westward dip, may be found in the diastrophic movements of the Central Mineral Region to the east and the formation of the Bend Arch. The Bend Arch is a geanticline extending northward from the Central Mineral Region almost to the Red River and was formed by the bowing of Cambrian and Pennsylvanian sediments toward the close of the Bend epoch of the latter period.

GEOLOGIC HISTORY[8]

[8] Much of this history was taken from--
Plummer, F. B. and Moore, R. C., "Stratigraphy of the Pennsylvania Formations of North-west Texas," University of Texas Bulletin No. 2132, 1921.

To obtain a complete geologic history of the area recourse must be made to the surrounding territory. In the Central Mineral Region the oldest formations are the Packsaddle schist and the Valley Spring gneiss, which were doubtlessly of sedimentary origin and later metamorphosed by great granitic intrusions in the Pre-Cambrian times. Prior to the Cambrian these Algonkian rocks were eroded away in many places, exposing the underlying granite, which, following the advance of the Upper Cambrian seas from the south, were overlain by Upper Cambrian sediments. The absence of Lower and Middle Cambrian sediments indicates that the region was above sea level and exposed to erosion during those times.

The varied character of the Upper Cambrian formations suggests an oscillating sea which was usually rather shallow and which never obtained any great depth until the time of the deposition of the Ellenburger limestone. This

sea persisted throughout most of the Ordovician, after which an uplift took place and the land was again exposed during a period of erosion which lasted throughout late Ordovician, Silurian, Devonian, and part of Mississippian times.

With the advance of the Pennsylvanian seas from the south and west deposition was resumed and, with the exception of three short erosional intervals, continued during Permian times. Deposits came from a land mass to the east.

At the end of the Permian the region was again uplifted and subjected to erosion during Triassic and Jurassic times. This erosional interval was brought to a close by the advance of the Cretaceous seas from the south-east.

During Tertiary times the region was again uplifted, causing the Balcones to the east. Subsequent erosion has reduced the area to its present level.

ECONOMIC PRODUCTS

Goats, sheep, and to a lesser extent, cattle furnish

the area its chief source of revenue. Hardly any farming is done. Some building stone and road-making materials are present, but the demand is not sufficient to make their exploitation profitable.

Fig. 1.
Anticlinal fold in the Wilberns formation.

Fig. 2.
Anticlinal fold in the Wilberns formation.

Fig. 3.
Looking up the dip of the Wilberns formation on the San Saba River.

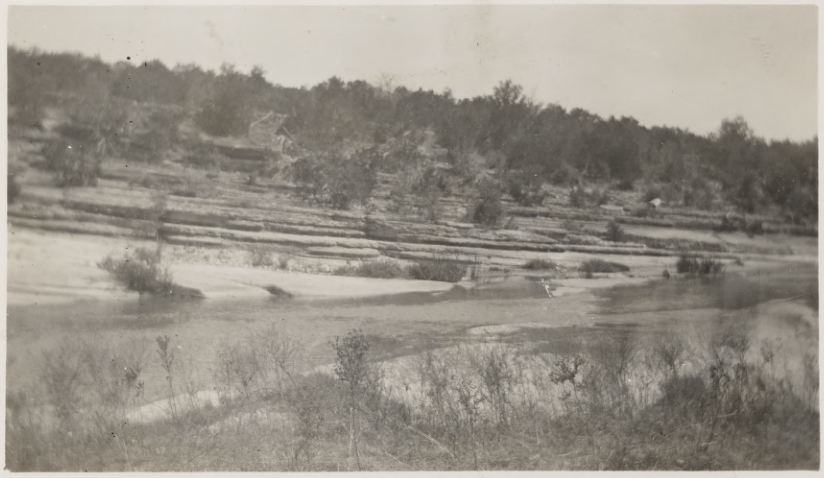

Fig. 4.
Dip of the Wilberns formation on the San Saba River.

Fig. 5.
Well bedded Ellenburger
limestone.

Fig. 6.
Poorly bedded Ellenburger limestone.

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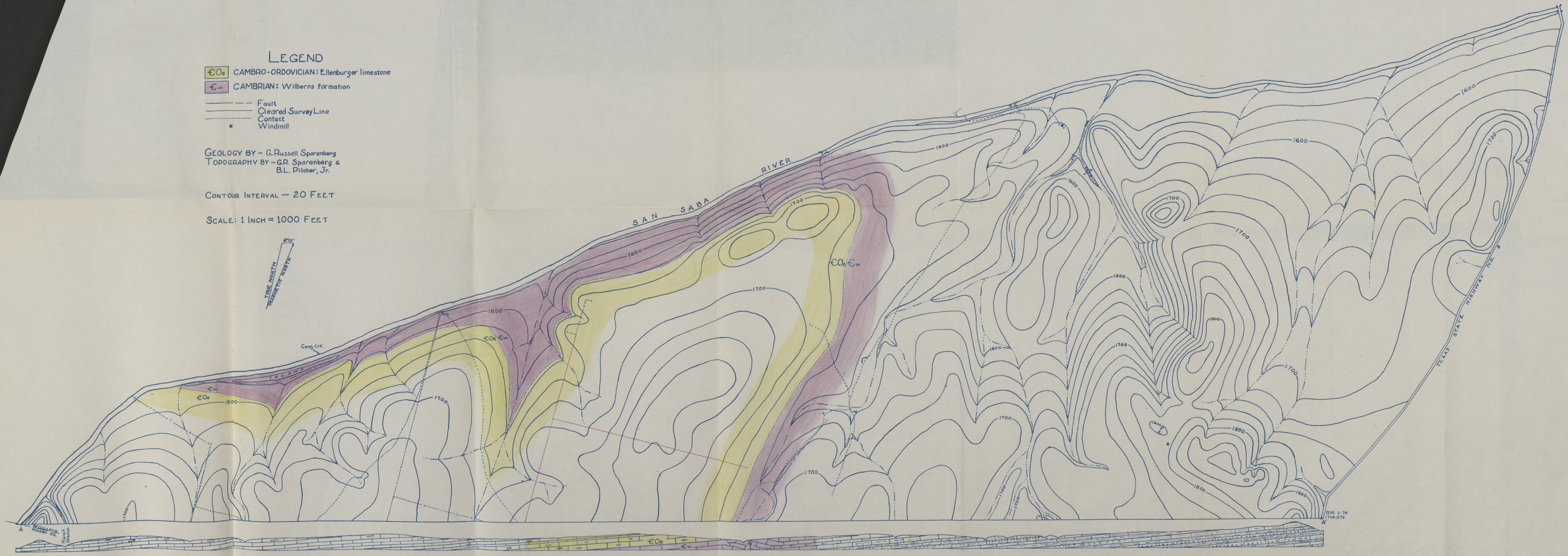
LEGEND

- €Oe — CAMBRO-ORDOVICIAN: Ellenburger limestone
- €w — CAMBRIAN: Wilberns formation
- Fault
- Cleared Survey Line
- Contact
- Windmill

GEOLOGY BY – G. Russell Sparenberg
TOPOGRAPHY BY – G.R. Sparenberg & B.L. Pilcher, Jr.

CONTOUR INTERVAL — 20 FEET

SCALE: 1 INCH = 1000 FEET



CROSS SECTION ALONG LINE A-A'
VERTICAL SCALE: 1 INCH = 500 FEET

PLATE 1